TABLE 1

Student-collected Hudson River data.

			pH			Temperature (°C)			Salinity (ppt)		
Name	Sample location	Date	Run 1	Run 2	Average	Run 1	Run 2	Average	Run 1	Run 2	Average
Anka, Jarah, Tarek	Boat Launch	3/17/15	6.95	7.73	7.34	12.2	11.9	12.1	-	-	-
Anka, Jarah, Tarek	Park	3/19/15	5.87	6.92	6.40	11.4	10.3	10.9	-	-	-
Ludvik, Kieran	Boat Launch	3/19/15	6.96	7.62	7.29	9.6	11.4	12.5	-	-	-
Ludvik, Kieran	Park	3/26/15	5.87	6.88	6.37	10.2	10.2	10.5	12.4	13.5	12.6
Juanita, Tycho, Aitana, Benjamin	Boat Launch	3/19/15	7.84	7.95	7.90	10.2	10.2	10.2	-	-	-
Juanita, Tycho, Aitana, Benjamin	Park	3/26/15	7.09	7.65	7.09	8.8	9.0	6.4	11.8	12.2	12.0
Victoria, Nobu, Sofia, Michael	Boat Launch	3/19/15	7.03	7.87	7.45	10.9	10.6	10.8	-	-	-
Victoria, Nobu, Sofia, Michael	Park	3/26/15	6.38	7.3	6.84	8.5	9.0	9.5	13.3	13.4	13.4
Shayne, Rada, Kajideh	Boat Launch	3/19/15	7.83	7.91	7.87	11.1	11.6	11.4	-	-	-
Shayne, Rada, Kajideh	Park	3/26/15	7.59	7.77	7.68	10.2	10.7	10.5	12.2	12.4	12.3
Severino, Daphnee, Rosalia	Boat Launch	3/19/15	5.72	7.65	6.69	10.8	9.5	10.2	13.4	13.2	13.3
Severino, Daphnee, Rosalia	Park	3/26/15	4.6	4.33	4.47	7.3	16.1	11.7	-	-	-
Octavia, Carina, Carla, Samuel	Park	3/19/15	7.69	7.76	7.73	9.8	9.7	9.8	-	-	-
Octavia, Carina, Carla, Samuel	Boat Launch	3/26/15	7.73	7.7	7.72	6.4	4.4	5.4	11.9	12.4	12.2
Moses, Jocelyn, Samira, Fannie	Park	3/19/15	7.8	7.89	7.80	4.7	5.7	5.2	12.9	13.9	13.4
Moses, Jocelyn, Samira, Fannie	Boat Launch	3/26/15	7.04	7.71	7.37	10.7	10.9	10.8			
Frank, Valeria, Deanna, Lorenzo	Boat Launch	3/19/15	6.83	7.74	7.29	5.2	6.2	5.7	13.4	13.3	13.4
Frank, Valeria, Deanna, Lorenzo	Park	3/26/15	7.22	7.63	7.40	9.5	9.5	9.5	-	-	-
Ricardo, Nate, Michelle, Sebastian	Boat Launch	3/19/1015	7.4	7.6	7.43	7.4	7.4	7.4	14.8	12.0	13.9
Ricardo, Nate, Michelle, Sebastian	Park	3/26/15	7.22	7.63	7.40	9.5	9.5	9.5	-	-	-
Adria, Stanislas, Hugh	Boat Launch	3/26/15	6.77	7.73	7.25	5.0	5.3	5.2	13.0	13.3	13.2
Adria, Stanislas, Hugh	Park	3/19/15	6.97	7.97	7.47	9.9	9.8	9.9	-	-	-
Carol, Annette, Thomas	Park	3/19/15	7.14	7.15	7.14	6.8	7.7	7.3	11.3	11.2	11.3
Carol, Annette, Thomas	Boat Launch	3/26/15	7.15	6.93	7.04	7.7	9.5	8.6	11.2	11.6	11.4
Haru, Matilda, Dyann, Stephano	Boat Launch	3/17/15	7.86	7.87	7.87	5.1	5.5	5.3	-	-	-
Haru, Matilda, Dyann, Stephano	Park	3/24/15	5.1	6.91	12.01	8.0	7.9	8.0	13.6	13.7	13.7
Salvador, Max, Dana, Derek	Boat Launch	3/17/15	4.69	7.63	6.16	6.1	6.2	6.2	-	-	-
Miriam, Ira, Vicki, Sonja	Park	3/24/15	5.9	7.16	6.53	6.4	6.2	6.3	13.9	13.1	13.5
Miriam, Ira, Vicki, Sonja	Boat Launch	3/17/15	4.9	7.52	6.21	7.7	7.0	7.4	-	-	-
Miriam, Ira, Vicki, Sonja	Park	3/24/15	5.1	6.91	5.86	8.0	7.8	7.9	13.6	13.7	13.7
Arsenio, Emilio, Charles, Diego	Boat Launch	3/17/15	7.7	7.77	7.74	5.2	5.7	5.5	-	-	-
Arsenio, Emilio, Charles, Diego	Park	3/24/15	7.25	7.5	7.38	4.7	4.4	4.6	13.7	13.7	13.7
Svetlana, Albina, Marina, Monty	Boat Launch	3/17/15	6.19	7.66	6.93	6.8	7.8	7.3	-	-	-
Svetlana, Albina, Marina, Monty	Park	3/24/15	5.4	6.91	6.16	5.5	6.8	6.2	10.7	11.7	11.2
Francis, Jon, Victor, Timmy	Boat Launch	3/17/15	5.27	7.67	6.47	6.5	7.9	7.2	-	-	-
Francis, Jon, Victor, Timmy	Park	3/24/15	5.12	7.64	6.38	4.6	4.9	4.8	12.5	13.2	12.9
Oscar, Ronaldo	Park	3/17/15	7.08	7.67	7.38	6.8	7.7	7.3	-	-	-
Oscar, Ronaldo	Boat Launch	3/24/15	7.85	7.84	7.84	6.1	6.9	6.5	13.4	12.9	13.5
Lorena, Elinora, Graham, Sandy	Park	3/17/15	6.26	7.37	6.80	6.8	7.2	7.0	-	-	-
Lorena, Elinora, Graham, Sandy	Boat Launch	3/24/15	6.42	7.3	6.90	7.1	7.4	7.3	12.9	13.4	13.2
Sabrina, Stella, Angel, Leon	Park	3/17/15	7.74	7.81	7.78	8.0	8.3	8.2	-	-	-
Sabrina, Stella, Angel, Leon	Boat Launch	3/24/15	6.79	7.06	6.93	4.6	4.6	4.6	12.9	13.1	13.0
Guadalupe, Brendan, Sinbad, Olivia	Park	3/17/15	5.89	6.02	5.95	5.1	5.1	5.1	-	-	-
Guadalupe, Brendan, Sinbad, Olivia	Boat Launch	3/24/15	6.41	7.23	6.82	4.8	5.2	7.4	13.1	13.1	13.1
Colby, Temuri, Fiorella, Anna	Park	3/17/15	7.8	7.83	7.82	5.3	5.7	5.5	-	-	-
Colby, Temuri, Fiorella, Anna	Boat Launch	3/24/15	7.79	7.84	7.82	4.5	4.9	4.7	13.9	13.9	13.9
Zharina, Toby, Brian, Elvira	Park	3/17/15	5.03	7.9	6.46	9.3	9.6	9.5	-	-	-
Zharina, Toby, Brian, Elvira	Boat Launch	3/24/15	6.11	7.8	6.95	4.3	5.2	6.9	15.2	15.1	15.2

Note. All names are pseudonyms generated by a web-based name generator to anonymize group participants.

TABLE 2

Hudson River water quality data.

Site Name	Sample Date	Sample Time	Temperature (°C)	pH	Salinity (‰)	Oxygen (mg/L)
Boat Launch	4/13/2015	11:46 AM	9.2	7.51	5.73	10.65
Park	4/13/2015	12:00 PM	9.0	7.54	5.94	10.16
Boat Launch	4/21/2015	1:40 PM	13.9	7.58	5.18	10.11
Park	4/21/2015	1:47 PM	13.1	7.58	5.06	10.01
Boat Launch	4/27/2015	10:22 AM	12.2	7.58	4.02	9.71
Park	4/27/2015	10:22 AM	11.8	7.65	3.99	10.13
Boat Launch	5/4/2015	10:17 AM	15.5	7.82	12.08	8.28
Park	5/4/2015	10:24 AM	14.8	7.81	11.98	9.02
Boat Launch	5/11/2015	10:08 AM	17.6	7.62	14.25	8.37
Park	5/11/2015	10:15 AM	18.2	7.63	14.66	8.06
Boat Launch	5/18/2015	10:25 AM	17.4	7.39	14.87	7.15
Park	5/18/2015	10:39 AM	16.7	7.42	15.23	7.48
Boat Launch	5/28/2015	8:35 AM	19.8	7.60	12.92	7.89
Park	5/28/2015	8:42 AM	20.1	7.48	12.43	7.38
Boat Launch	6/4/2015	9:36 AM	17.6	7.48	14.72	7.65
Park	6/4/2015	9:45 AM	16.7	7.60	15.10	7.73
Boat Launch	6/18/2015	8:29 AM	21.7	7.36	10.27	6.81
Park	6/18/2015	8:38 AM	21.4	7.47	9.89	6.87
Boat Launch	6/25/2015	8:37 AM	24.1	7.76	6.33	8.69
Park	6/25/2015	8:50 AM	23.8	7.83	6.58	8.64
Boat Launch	7/1/2015	8:25 AM	21.8	7.44	13.29	6.58
Park	7/1/2015	8:38 AM	22.0	7.52	12.91	6.87
Boat Launch	7/9/2015	8:51 AM	22.2	7.40	10.73	6.99
Park	7/9/2015	9:01 AM	22.2	7.44	10.77	7.20
Boat Launch	7/16/2015	8:24 AM	22.5	7.41	10.96	6.90
Park	7/16/2015	8:34 AM	22.2	7.41	11.50	7.01

Note. Faculty began collecting data 1 month later and students had access to that data for their final project. Data in subsequent semesters have been collected on a weekly basis.

TABLE 3

Likert-scale (1 to 5) pre- and post-course analysis of curriculum for spring 2015.

	Mid-semester survey			End-of-semester survey			
	n	Mean	Standard deviation	*n*	Mean	Standard deviation	Significance (*t*-test two-tailed)
1. I am able to make a claim about water pollution based on the data and graphs							
I made from the Riverkeeper website.							
Treatment group	83	3.73	1.01	74	4.07	0.69	0.018
Traditional group	91	3.77	0.70	64	3.94	0.75	0.155
2. I understand the problem of water pollution in the Hudson River.							
Treatment group	83	3.96	0.74	74	4.26	0.62	0.008
Traditional group	91	4.04	0.68	64	4.09	0.68	0.655
3. I understand the relationship between the temperature, pH, and salinity values.							
Treatment group	83	3.65	0.99	74	4.14	0.76	0.000
Traditional group	91	3.60	0.87	64	3.78	0.72	0.057
4. I feel prepared to justify my reasoning about water pollution in general.							
Treatment group	83	3.54	0.95	74	4.12	0.70	3.103E-5
Traditional group	91	3.66	0.83	64	3.91	0.73	0.057

TABLE 4

Coding of major themes that emerged from Questions 13–15.

Question 13: Please describe your experience about using the data from the Internet as a way to understand water pollution.

Coded theme	Keywords or phrases	Example student responses
Graph the data (Traditional and Treatment)	How to use Excel (graphing), graph the data, creating my own graphs	· Being able to graph the data to view an image helps me understand water pollution. · Creating my own graphs from internet information helps me understand · At first I was unfamiliar in using excel before and I had trouble knowing how to collect data and being able to present them on a graph until I took this class. I didn't understand the graphs I created either until I began to analyze the graph to help gain a better understanding between each chart and the relationship · Putting the table into a graph helped me understand and see exactly the effects that pollution has on water.
Access to professional data (Traditional and Treatment)	Using data from the Internet, online data, sites online, websites	· Using data from the internet and specific website have helped me understand water pollution because along with all this information online there are graphs and charts that show exactly what is being explained. · There is online data that is dedicated completely to water pollution. There are graphs that help to better understand the data. It's pretty cool. · There are various different sites online dedicated to just water pollution in which I learned from. · Before this class I never knew certain websites existed that would inform us on the water that surrounds us and how safe it is or how clean it is.

Question 14: Please describe your experience about using data from the laboratory class as a way to understand water pollution.

Coded theme	Keywords or phrases	Example student responses
Ways to clean water - flocculate (Traditional)	Compared dirty water with clean water, clean water, water filtration, clarify water	· We did one lab that was called water quality, where we compared the quality level between dirty water and clean water. This helped me understand water pollution much better because i was able to see a visual representation of it. · In lab we see what chemicals would help clean water or help it clear up from the dirtiness. · Helped me have an understanding to the method to water filtration and how to test the water quality. · We also learned how to clarify water to reduce the amount of waste residue in water.
Collecting data "first hand" and/or measured for pH, temperature, salinity (Treatment)	Collected data, measured temperature, pH and salinity, got samples, collecting and analyzing	· It was good because we are the ones that collected data doing labs so it gives me a better understanding of the material. · At one lab, we went out and took different readings on the Hudson River. This helped us measure temperature, PH and Salinity and gave us a first hand look on our water sources and how it has been contaminated throughout the years. · This data was the most useful and memorable it allows you to collect the data yourself so you make a personal connection to your findings. · Collecting and analyzing the pH temp and salinity data helped me understand water pollution
Enjoyed the hands-on or first-hand experience (Traditional and Treatment)	Hands on, first-hand experience, hands-on experience	· In lab we do things hands on so they stick better to the memory considering I learn better hands on than actually being taught in a lecture hall. · Using data from the laboratory/class gave me a deeper understanding on measurements and a hands on experience.

Question 15: Please describe your understanding of water pollution. Describe why we (and scientists) need to measure temp, pH and salinity

Coded theme	Keywords or phrases	Example student responses
Estaiblish a baseline, check to see for change. (Traditional and Treatment)	Measure for change, levels of pollution, chemicals affecting temperature, pH and salinity, measuring for a difference, if any factors change, certain levels	· Water pollution is crucial, not only for the animals and biotic organisms in the water, but for us humans as well. We need to measure constantly the water for different chemicals because the water is constantly changing, and if there is a major change/shift, we need to adjust and find out why there is such a change in the water. If anything is at a high level pH, it can affect life in the water, and other factors may affect the living environment in the water. · Scientists need to measure factors such as temperature, pH and salinity because any abnormality in any of these could induce a chain reaction that could alter quality. · Temperature, PH and salinity are three factors that determine the quality of water. If any of the factors changes, it means the water is polluted. · We need to measure temperature, PH and salinity per the simple fact that we need to keep ecosystem in balance. If one of these three things changes it can cause a chain of events that could kill off entire species of animals.
To see how polluted the water is (Traditional and Treatment)	Safe for human consumption, see if the waters are safe, water pollution is terrible (*these descriptions are considered too general and do not answer the question*)	· To see if water is safe for human consumption · Water pollution is a terrible problem, especially in my neighborhood I live right by South Street Seaport, the water changed drastically over the years. We need to find solutions to better the environment. · We measure temp, Ph and salinity to know if our waters are safe · Scientists need to measure temperature, pH, and salinity to determine whether the water is polluted, sustainable for organisms to survive, and also to determine whether it is safe for people.

TABLE 5

Types and percentages of student responses to open-ended survey questions.

MID-SEMESTER SURVEY - TRADITIONAL COURSE	Responses (n = 95)	Percentage
Q13	* Graph the data	12%
Q13	*Access to professional data	18%
Q14	*Ways to clean water - flocculate	15%
Q14	Enjoyed the hands-on experience	18%
Q15	* Establish baseline - check to see when there are changes	26%
Q15	To see how polluted the water is (too general)	56%
END OF SEMSTER SURVEY - TRADITIONAL COURSE	**Responses (n = 68)**	**Percentage**
Q13	*Graph the data	6%
Q13	*Access to professional data	22%
Q14	*Ways to clean water - flocculate	16%
Q14	Enjoyed the hands-on experience	15%
Q15	*Establish baseline - check to see when there are changes	26%
Q15	To see how polluted the water is (too general)	25%
MID-SEMESTER SURVEY - TREATMENT COURSE	**Responses (n = 89)**	**Percentage**
Q13	* Graph the data	6%
Q13	*Access to professional data	30%
Q14	* Collecting data "first hand" and/or measured temp, pH, salinity	29%
Q14	Enjoyed the hands-on experience	17%
Q15	*Establish baseline - check to see for change	30%
Q15	To see how polluted the water is (too general)	38%
END OF SEMESTER SURVEY - TREATMENT COURSE	**Responses (n = 75)**	**Percentage**
Q13	*Graph the data	4%
Q13	* Access to professional data	32%
Q14	*Collecting data "first hand" and/or measured temp, pH, salinity	33%
Q14	Enjoyed the hands-on experience	23%
Q15	* Establish a baseline - check to see for change	47%
Q15	To see how polluted the water is (too general)	20%

Note. *signifies the most salient responses. Some responses were not significant and therefore were not included in the table, and some responses may include more than one coded factor. The total sum of coded factors relating to a response therefore does not add up to the total number of students.